

# Headaches and the N95 face-mask amongst healthcare providers

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**Background:** During the 2003 severe acute respiratory distress syndrome epidemic, healthcare workers mandatorily wore the protective N95 face-mask. **Methods:** We administered a survey to healthcare workers to determine risk factors associated with development of headaches (frequency, headache subtypes and duration of face-mask wear) and the impact of headaches (sick days, headache frequency and use of abortive/preventive headache medications).

**Results:** In the survey, 212 (47 male, 165 female) healthcare workers of mean age 31 years (range, 21–58) participated. Of the 79 (37.3%) respondents who reported face-mask-associated headaches, 26 (32.9%) reported headache frequency exceeding six times per month. Six (7.6%) had taken sick leave from March 2003 to June 2004 (mean 2 days; range 1–4 days) and 47 (59.5%) required use of abortive analgesics because of headache. Four (2.1%) took preventive medications for headaches during this period. Multivariate logistic regression showed that pre-existing headaches [ $P = 0.041$ , OR = 1.97 (95% CI 1.03–3.77)] and continuous use of the N95 face-mask exceeding 4 h [ $P = 0.053$ , OR = 1.85 (95% CI 0.99–3.43)] were associated with development of headaches. **Conclusions:** Healthcare providers may develop headaches following the use of the N95 face-mask. Shorter duration of face-mask wear may reduce the frequency and severity of these headaches.

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## Introduction

In the fall of 2002 in Guangdong, China, there arose reports of an outbreak of atypical pneumonia, particularly prevalent amongst healthcare workers and their family members. By March 2003, the disease, named severe acute respiratory syndrome (SARS), had reached epidemic proportions; having spread to Hong Kong, South-East Asia (Singapore and Vietnam) and Canada through travel from affected countries (1, 2). SARS is caused by a coronavirus, and is spread by respiratory droplets (3).

At the height of the crisis, healthcare workers in our country were mandated to wear personal protective equipment (PPE) during contact with patients suspected of having SARS. This entailed the wearing of close-fitting N95 face-masks, goggles, gowns and surgical gloves for contact

with all patients and the use of the powered air-purifying respirators (PAPR) for all high-risk or aerosol-generating procedures (3, 4). In practice, healthcare workers wore PPE for prolonged periods (exceeding 4 h) when handling all patients, even in the absence of respiratory symptomatology or fever.

The N95 face-mask protects against respiratory droplets, the number 95 signifying that it is at least 95% efficient in filtering particles with a median diameter  $> 0.3 \mu\text{m}^2$ , and the letter N that the mask is not resistant to oil (4). The N95 face-mask is associated with mild discomfort (4, 5), but headaches have not been previously reported. We observed complaints of headaches and discomfort amongst healthcare workers who wore the N95 face-masks, and elected to study this phenomenon.

The aim of our study was to determine the prevalence of headaches from the use of N95 face-

mask amongst healthcare workers in our institution. We also sought to determine the headache subtypes, identify risk factors for the development of headaches and determine the impact of headaches in terms of the number of sick days, frequency of headaches and the use of abortive or preventive headache medications.

### Methods and subjects

The study was performed at a tertiary hospital in our country, where the use of the N95 face-mask was mandated amongst healthcare workers based in high-risk areas such as intensive care units, isolation wards, emergency rooms, operating theatres and general medical wards during the SARS outbreak from March 2003 to March 2004. Healthcare workers not exposed to these high-risk areas and who did not wear the N95 face-mask, were excluded from the study. A year following the first reported case of SARS in our country, 250 sets of questionnaires were randomly distributed to respondents working in these high-risk areas in March 2004. We obtained approval from our hospital's ethics committee to carry out the survey.

A self-administered questionnaire was completed by the healthcare workers. We sought to determine the frequency of headaches (new onset or exacerbation of pre-existing headaches), subtype, risk factors for development and severity of headaches. Demographic information such as age, gender, ethnicity and occupation were obtained. Respondents were asked about pre-existing headaches, the nature of such headaches, if present (i.e. whether the headaches were unilateral/bilateral, pulsating, bandlike, associated with nausea, vomiting, photophobia, phonophobia, congestion of the eyes/nose or facial sweating). We asked if wearing the N95 face-mask resulted in headaches, either arising *de novo* or due to exacerbation of pre-existing headaches. Based on these headache characteristics, we subtyped the headaches based on International Headache Society recommendations (6).

A diagnosis of migraine was made if at least two of the following were present: (i) unilateral location; (ii) pulsating quality; (iii) moderate or severe pain intensity; (iv) aggravation by or causing avoidance of routine physical activity; and (v) the presence of at least one of the following: nausea/vomiting and photophobia/phonophobia. Tension-type headache was diagnosed in the presence of at least two of the following: (i) bilateral location; (ii) bandlike quality; (iii) mild or moderate intensity; (iv) not aggravated by routine physical activity such as walking or climbing stairs; and

(v) the absence of nausea, vomiting, photophobia or phonophobia. Cluster headache was diagnosed in the presence of at least one of the following: (i) ipsilateral conjunctival injection or lacrimation; (ii) nasal congestion; (iii) eyelid edema; and (iv) facial sweating. Those respondents with headache, in whom a subtype of headache could not be diagnosed based on this questionnaire, were categorized as having 'unspecified headaches'.

Frequency of headaches (number of headaches in a month), duration of continuous wear of the N95 face-mask (less than or exceeding 4 h during each period of use), use of abortive analgesics and preventive medications and the number of sick days because of headache were obtained from these respondents.

All statistical analyses were performed using the SPSS package (Release 13.0, SPSS Inc., 2003, Chicago, IL, USA). Descriptive analyses were used to study the demographic characteristics and study variables. The prevalence (with 95% CI) of worse headaches with the use of the N95 face-mask was determined. Univariate and multivariate logistic regression were used to compare these study variables (demographic, headache characteristics, continuous wear of the N95 face-mask exceeding 4 h and pre-existing headaches) with outcome measures (worse headaches with the use of the N95 face-mask). Statistical significance was set at  $P < 0.05$ .

### Results

In this study, 212 healthcare workers, 47 male (22.2%) and 165 female (77.8%), of mean age 31 years (standard deviation, 7; range, 21–58) participated. They were of Chinese ( $n = 123$ ; 58.0%), Malay ( $n = 26$ ; 12.3%), Indian ( $n = 22$ ; 10.4%) and Filipino ( $n = 30$ ; 14.2%) origins. Of the participants, 56 (26.4%) were doctors, 140 (66.0%) were nurses and the remaining 16 (7.6%) were paramedical personnel (Table 1). The response rate, measured by the number of respondents to the number of questionnaires distributed, was 84.8%.

Of the 212 (37.3%) respondents, 79 reported headaches when they wore the N95 face-mask. Of these 79 respondents, 27 (37.3%) had pre-existing headaches, 52 (62.7%) had no pre-existing headaches, 25 (31.6%) had migraine headaches, 43 (54.4%) had tension-type headaches, 11 (13.9) had unspecified headaches and none had cluster headaches. Pre-existing headaches ( $P = 0.041$ ; OR = 1.97; 95% CI 1.03–3.77) and continuous wear of the N95 face-mask ( $P = 0.053$ ; OR = 1.85; 95% CI 0.99–3.43) were associated with headaches amongst N95 face-mask users. No one headache

subtype was found to predispose to N95 face-mask-associated headaches. There were no statistical differences in gender, age, ethnicity and occupation amongst those respondents with and without headaches following the use of the N95 face-mask (Table 2).

Of the 79 respondents with N95 face-mask headaches, 26 (32.9%) suffered more than six headaches in a month, six (7.6%) had taken sick leave (because of headache) from March 2003 to June 2004 (mean 2 days; range 1–4 days) and 47 (59.5%) had headaches that required the use of

abortive analgesics. Of these 47 healthcare workers, 41 (87.2%) had taken abortive analgesics at a frequency exceeding 2 days in a month. Four (2.1%) of these workers were on preventive medications for headache during this period.

## Discussion

The N95 face-mask is generally well tolerated, with minimal adverse effects such as vague discomfort (mask tightness and difficulty breathing) (4) and acne (7). This study describes the phenomenon of headaches associated with the use of the N95 face-mask. About a third of healthcare providers surveyed in this study reported headaches with the N95 face-mask wear and we identified pre-existing headaches and prolonged duration of N95 face-mask wear as important risk factors for the development of these headaches. A majority of these healthcare providers required the use of abortive medications ( $n = 47$ , 60%), but only a minority of them were on preventive medications ( $n = 4$ , 2%). Although headaches have been reported with the donning of objects with straps, such as helmets (8, 9), goggles (10) and brassieres (11), its association with the N95 face-mask have not been previously described.

The etiopathogenesis of N95 face-mask-associated headaches could possibly be related to hypoxemia, hypercapnia, mechanical factors or the stress associated with its use. Headaches have been ascribed to both hypoxemia and hypercarbia (6), the latter notably in scuba divers who develop

**Table 1** Demographic characteristics of 212 healthcare workers who wore the N95 face-mask during the severe acute respiratory distress syndrome crisis

Characteristics	Patients, $n = 212$ (%)
Age (years) (mean $\pm$ SD)	31 $\pm$ 7
Gender	
Male	47 (22.2)
Female	165 (77.8)
Ethnicity	
Chinese	123 (58.0)
Malay	26 (12.3)
Indian	22 (10.4)
Caucasian	1 (0.01)
Filipino	30 (14.2)
Other	10 (0.05)
Occupation	
Doctor	56 (26.4)
Nurse	140 (66.0)
Paramedical personnel	16 (7.6)
Duration of N95 wear exceeding 4 h	102 (48.1)
Pre-existing headaches	55 (25.9)
Worse headaches with wearing the N95 face-mask	79 (37.3)

**Table 2** Comparison of demographic variables, duration of N95 face-mask use and pre-existing headache amongst healthcare workers with and without headache exacerbations following the use of the N95 face-mask

Demographic variables	With headache, $n = 79$ (%)	Without headache, $n = 132$ (%)	$P$ -value <sup>1</sup>	Odds ratio (95% Confidence interval)
Gender				
Male	14 (17.7)	33 (25.0)	0.249	0.568 (0.216–1.488)
Female	65 (82.3)	99 (75.0)		1.0
Age (years) (mean $\pm$ SD)	30 $\pm$ 6	32 $\pm$ 8	0.153	0.966 (0.920–1.013)
Ethnicity				
Chinese	44 (55.7)	79 (59.8)	0.818	1.0
Malay	9 (11.4)	17 (12.9)		0.807 (0.313–2.081)
Indian	9 (11.4)	13 (9.8)		1.204 (0.460–3.148)
Caucasian	0	1 (0.8)		1.647 (0.665–4.075)
Filipino	13 (16.5)	17 (12.9)		1.795 (0.438–7.357)
Other	4 (5.1)	6 (3.8)		1.895 (0.318–4.537)
Occupation				
Doctor	21 (26.6)	35 (26.5)	0.394	1.805 (0.732–4.450)
Nurse	52 (65.8)	87 (65.9)		1.0
Paramedical personnel	6 (7.6)	10 (7.6)		1.568 (0.484–5.084)
Duration of N95 wear exceeding 4 h	44 (55.7)	58 (43.9)	0.053	1.85 (0.99–3.43)
Pre-existing headaches	27 (37.3)	28 (21.2)	0.041**	1.97 (1.03–3.77)

<sup>1</sup>Multiple logistic regression (statistically significant if  $P < 0.05$ ).

\*\*Statistically significant.

hypercarbia secondary to inadequate ventilation of compressed gases (12). Hypoxemia was similarly observed from the use of the N95 face-masks, where increased respiratory rate and higher incidence of chest discomfort were observed during the use of the N95 face-mask for a 4-hour stretch (13). Partial pressure of carbon dioxide was, unfortunately, not assessed in the study.

Cervicogenic headaches [a headache subtype that describes headaches arising from the neck that are precipitated by neck movement and/or sustained awkward head positioning (6, 14)] is usually described in association with an underlying cervical pathology. It is possible that the headaches occurring in those wearing helmets, goggles and close-fitting N95 face-masks may have arisen due to pressure from the strap on the neck or back of the head over the superficial nerves, may aggravate an underlying cervical neck strain and exacerbate face-mask-associated headaches. The contribution of stress to the development of headaches is suggested by a proportion of respondents who developed tension-type headaches ( $n = 43$ , 54.4%) compared with the other headache subtypes. Stress is known to exacerbate tension-type headaches (15), but is also described with migraines and cluster headaches (16).

Our study has several limitations. As the study was performed amongst healthcare providers based in high-risk areas, the study sample may not have included healthcare providers who had avoided or been excused from working in such areas because of headaches. Factors other than use of the N95 face-mask, such as psychological stress and sleep disturbances, which could have influenced the development of headaches, were not included in this study. Although the study was performed a year following the first-reported case of SARS in our country, recall biases were limited as the respondents were still wearing the N95 face-masks during the study period. Future studies of N95 face-mask-associated headaches should preferably be prospectively designed, with study controls, and should include the assessment of psychological stress and sleep disturbances.

Although the SARS epidemic appears to be contained, and infection control measures have been relaxed in affected countries, the threat of new epidemics such as the avian influenza outbreak in Vietnam and Thailand (17) remind us of the need for constant vigilance, and make the wearing of personal protective equipment, including

close-fitting N95 face-masks, a necessity. This study highlights the relatively high prevalence of headaches with the use of the N95 face-mask amongst healthcare workers working in high-risk areas. Shorter duration of face-mask wear may reduce the frequency and severity of these headaches. Further studies should be performed to confirm this observation and elucidate the mechanisms underlying this association.

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